

Title: Fascinating Friction!

Brief Overview:

This unit involves collecting, recording, organizing, and displaying data. Students will use this data to analyze possible scientific and mathematical outcomes in an experiment. Students will make predictions, interpret results, and draw conclusions. This physical science unit involves the collection of data on various surfaces with more or less friction.

Links to NCTM Standards:

- **Mathematics as Problem Solving**
Students will demonstrate their ability to solve problems in mathematics including problems with open-ended answers, problems which are solved in a cooperative atmosphere, and problems which are solved with the use of technology.
- **Mathematics as Communication**
Students will demonstrate their ability to communicate mathematically. They will read, write, and discuss mathematics with language and the signs, symbols, and terms of the discipline.
- **Mathematics as Reasoning**
Students will demonstrate their ability to reason mathematically. They will make predictions, gather evidence, and draw conclusions.
- **Mathematical Connections**
Students will demonstrate their ability to connect mathematics topics within the discipline and with other disciplines.
- **Number Sense and Operations**
Students will demonstrate their ability to describe and apply number relationships using concrete and abstract materials. They will choose appropriate operations and describe effects of operations on numbers.
- **Measurement**
Students will demonstrate knowledge of using standard units of measure. They will estimate and verify measurements, applying measurements to interdisciplinary and real world problem-solving situations.
- **Statistics**
Students will demonstrate their ability to collect, organize, and display data. They will interpret information obtained from displays, and will write reports based on statistical information.

Grade/Level:

Grades 3-5.

Duration/Length:

Approximately 4-5 days.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Measurement
- Estimation
- Frequency tables
- Computation of whole numbers
- Graphing
- Explanatory writing
- Predicting outcomes

Objectives:

Students will be able to:

- collect, record, organize, and analyze data.
- work cooperatively in group situations.
- identify measurements using ruler or tape measure.
- apply estimation strategies.
- construct frequency tables.
- develop an explanatory paragraph.
- calculate averages from collected data.
- construct and interpret bar graphs.
- apply learning to real life experiences.
- communicate findings orally and in writing.

Materials/Resources:

- Rulers
- Calculators
- Markers or Colored Pencils
- Graph Paper
- Brainstorming Activity Sheet / Student Resource #1
- Frequency Tables / Student Resource #2, #3
- Graphic Organizer Activity Sheet / Student Resource #4
- Writing to Explain Prompt / Student Resource #5

- Sentence Strips / Teacher
- Ramp Surfaces (cardboard boxes, wood, foam core, etc.)
- Assortment of Balls (marbles, tennis, golf, rubber, etc.)
- Surface Materials for Ramps (felt, sandpaper, waxed paper, vinyl, foam, etc.)
- Textbooks for Ramp Height
- Tape Measure
- Overhead or Chalkboard
- Brainstorming Transparency /Teacher Resource #1
- Frequency Table Transparencies /Teacher Resource #2, #3
- Graphic Organizer Transparency / Teacher Resource #4
- Writing to Explain Prompt Transparency / Teacher Resource #5
- Bar Graph Scoring Rubric / Teacher Resource #6
- Writing to Explain Rubric / Teacher Resource #7

Development/Procedures:

Activity 1:

1. Teacher will introduce the theme of “friction.”
2. Teacher will use sentence strips to introduce new vocabulary terms and define. (friction, distance, average, frequency, variable, control, etc.)
3. Teacher will share examples of friction with class (roller skates, biking, walking, matchbox cars, etc.)
4. Students will work in pairs and generate examples of friction and write on their Brainstorming Activity Sheet.
5. Teacher will use Brainstorming Activity Transparency on the overhead to clarify student examples.
6. Homework - List examples of friction found in the classroom or at home.

Activity 2:

1. Teacher reviews examples of friction and vocabulary.
2. Teacher passes out Frequency Table.
3. Teacher explains Frequency Table; title, labels, tallies, on overhead transparency.

4. Teacher will construct a ramp using various surfaces at the bottom to demonstrate changes in friction by rolling a marble down the ramp. He/She will conduct 5 trials on each surface. For each trial, the teacher or student volunteers will measure the distance the marble traveled, and record on frequency table.
5. Teacher will reinforce method of finding averages (calculators as needed).
6. Students will calculate averages of each of 5 trials and document average on frequency table.

Activity 3:

1. Discuss components of a bar graph.
2. Share bar graph rubric, discuss expectations.
3. Distribute graph paper and materials.
4. Students will construct a bar graph from frequency table data according to rubric.
5. Teacher collects and scores according to rubric.

Activity 4:

1. Teacher prepares optional cooperative group stations for ball/ramp experiments.
2. Teacher divides class into cooperative learning groups.
3. Review guidelines for cooperative group activities.
4. Explain purpose of group experiments (test different balls on constant surface).
5. Complete frequency table and bar graph (follow similar procedures from previous graphing activity).
6. Draw conclusions based on data.
7. Display group bar graphs and discuss outcomes.

Activity 5:

1. Analyze conclusions drawn from experiments.
2. Distribute and discuss explanatory writing prompt according to desired expectations.
3. Optional: use FAT PIG format (see explanation on Teacher Resource #5).
4. Complete graphic organizer (group or individual), using “think abouts” from writing prompt.
5. Develop rough draft form graphic organizer and data collection.
6. Edit and revise rough draft (individual or peer evaluation).
7. Prepare final copy of writing prompt.
8. Teacher scores according to “Writing to Explain Rubric.”

Performance Assessment:

This unit provides on-going assessment through performance-based instruction. The teacher assesses student learning using observation. A performance-based assessment is provided in activities 3, 4, and 5. These assessments include accompanying teacher scoring rubrics.

Extension/Follow Up:

1. Read Forces in Action, by Kathryn Wyman (pages 14-17).
2. Read Force, the Power Behind Movement, by Eric Laithwaite (pages 12-15).
3. Search the Internet for additional information about friction.
4. Create a game that demonstrates the forces of friction.
5. Research the three types of friction.
6. Create a line plot or stem and leaf plot to display data.
7. Complete a scatter plot displaying correlating data between variables.

Authors:

Robyn D. Morris
Westside Intermediate School
Wicomico County, MD

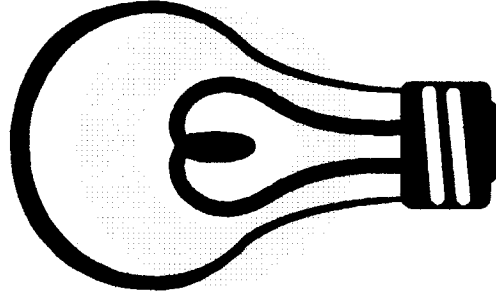
Monica W. Snee
Washington High School
Somerset County, MD

Beverly G. Riffin
Washington High School
Somerset County, MD

Name: _____

Date: _____

Fascinating Friction!
Brainstorming Transparency
Teacher Resource #1

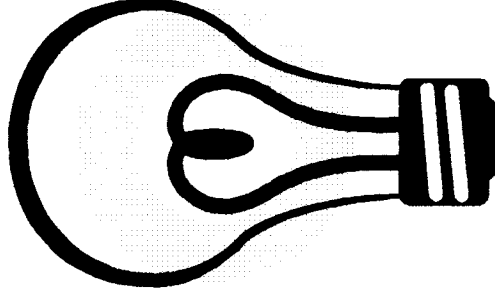


Examples of Friction

Name: _____

Date: _____

Fascinating Friction!
Brainstorming Activity Sheet
Student Resource #1



Examples of Friction

Name: _____

Fascinating Friction!
Frequency Table Transparency
Teacher Resource #2

Date: _____

Ramp Surface Frequency Table

Material	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Total	Average

1. Which material slowed the marble down? Why?

2. Which material allowed the marble to roll the farthest distance? Why?

Name: _____

Date: _____

Ramp Surface Frequency Table

Material	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Total	Average

1. Which material slowed the marble down? Why?

2. Which material allowed the marble to roll the farthest distance? Why?

Name: _____

Fascinating Friction!
Frequency Table Transparency
Teacher Resource #3

Date: _____

Ball Roll Frequency Table

Type of Ball	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Total	Average

1. Which ball rolled the shortest distance? Why?

2. Which ball rolled the farthest distance? Why?

Name: _____

Fascinating Friction!

Frequency Table

Date: _____

Student Resource #3

Ball Roll Frequency Table

Type of Ball	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Total	Average

1. Which ball rolled the shortest distance? Why?

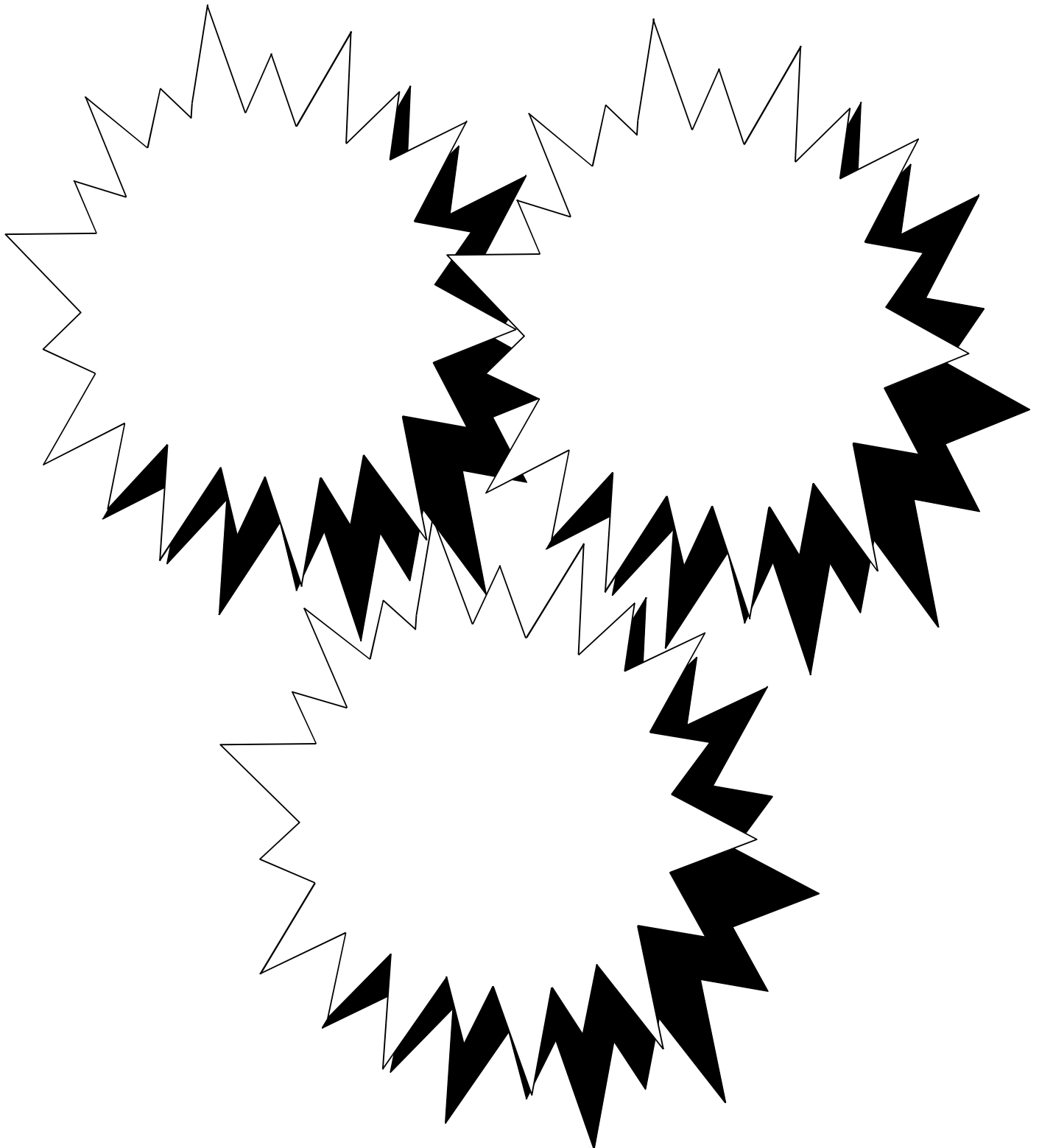
2. Which ball rolled the greatest distance? Why?

Name: _____

Date: _____

Fascinating Friction!
Graphic Organizer Transparency
Teacher Resource #4

“THINK ABOUTS”

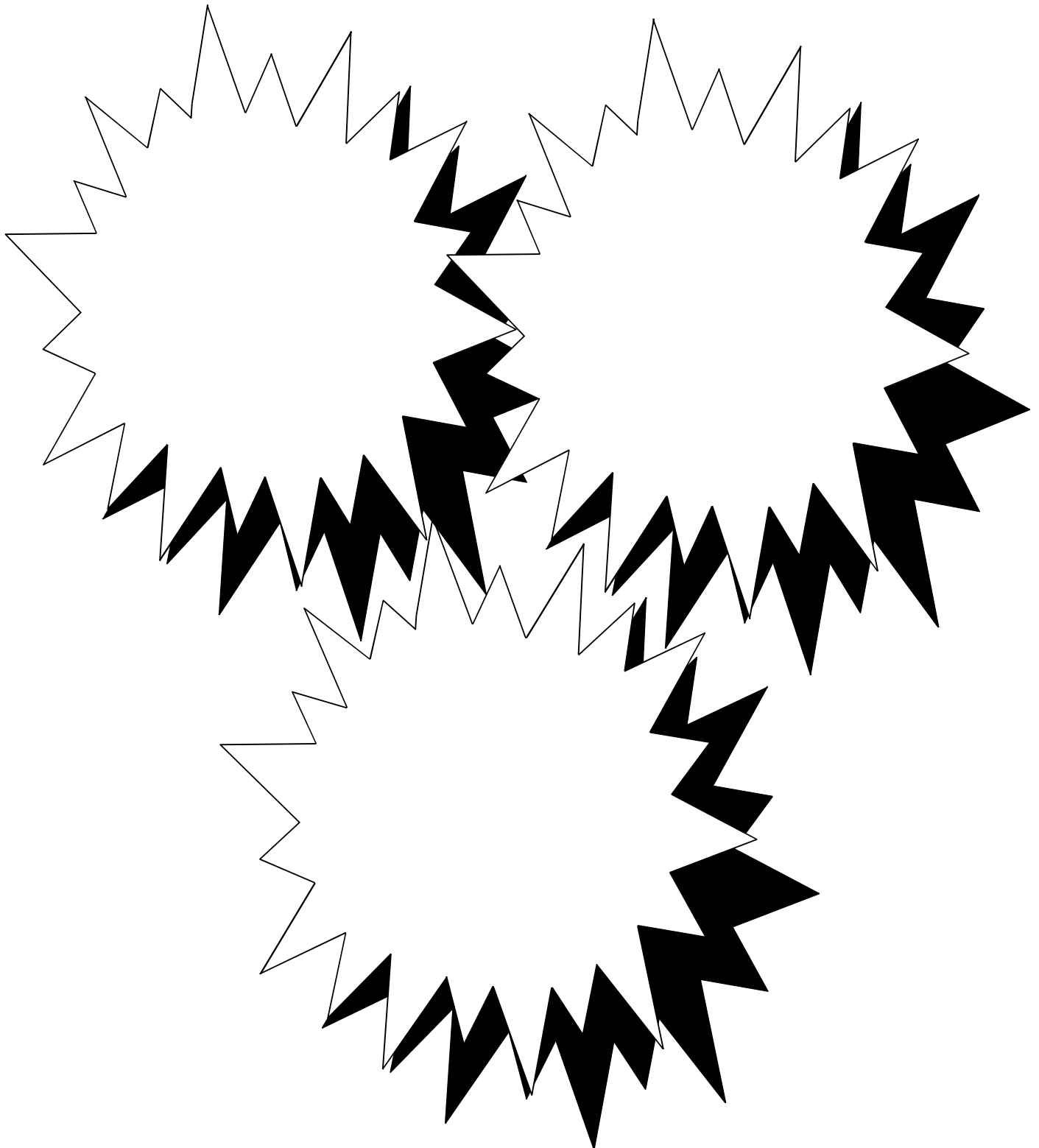


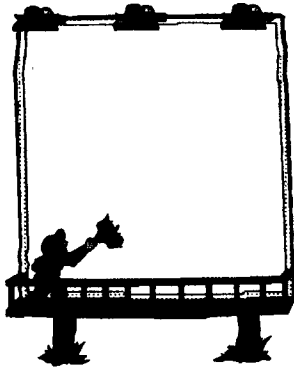
Name: _____

Date: _____

Fascinating Friction!
Graphic Organizer
Student Resource #4

“THINK ABOUTS”





Teacher Resource #5

“Writing to Explain Prompt”

Your science class is making an entry in the Science Fair. You have chosen a unit on “friction”. You have completed data collection, and the surfaces that can affect it. Now, write a paragraph to the judges of the Science Fair explaining the effects of different surfaces on friction.

Before you begin to write, think about what friction is. Think about what causes a change in friction based on your experiments, and think about several examples of friction in your everyday life.

Now, write a paragraph to the judges of the Science Fair, explaining friction, and its’ effects.

F (form) Did the student write in the correct format? (Paragraph, letter, etc.)

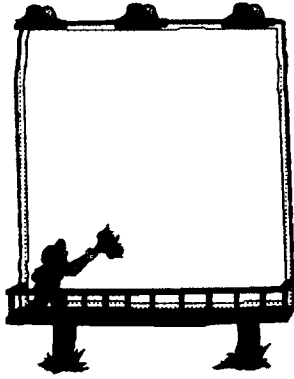
A (audience) Did the student write to the correct audience?

T (topic) Did the student write on the correct topic?

P (purpose) Did the student have the right purpose? (Tell, explain, persuade)

I (inform) Did the student answer the think about questions?

G (guidelines) Did the student follow the correct guidelines?



Student Resource #5

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**F
A
T
P
I
G**

BAR GRAPH SCORING RUBRIC

SCORE: 4

Three facts are clearly written in sentences.
An accurate title is given.
Two axes are drawn correctly.
Two axes labels are correctly given.
Numbers are clear and correct.
The bars are drawn to the correct numbers.
The bars are labeled correctly.
The writing is clear.

SCORE: 3

Two facts are clearly written in sentences.
An accurate title is given.
Two axes are drawn correctly.
Two axes labels are correctly given.
Numbers are clear and correct.
The bars are drawn to the correct numbers.
The bars are labeled correctly.
The writing is clear.

SCORE: 2

One accurate fact is written.
The title is given, but is incorrect.
One axis is correctly drawn.
One axis label is correct.
Numbers are clear, but not correct.
Bars are labeled.
Bars are drawn.
Writing is clear.

SCORE: 1

No facts are correct.
Axes are incorrectly drawn.
Numbers are incorrect and unclear.
Bars are not correct.
Writing is not clear.

Writing to Explain Rubric

Score	Development	Organization	Audience	Language
3 Exemplary	Provides extensive information on the topic.	Has an organized plan.	Provides extensive information relevant to the needs of the audience.	Provides extensive language choices to enhance the topic.
2 Adequate	Provides adequate information on the topic.	Has an organized plan with some minor flaws.	Provides adequate information relevant to the needs of the audience.	Provides frequent language choices to enhance the topic.
1 Needs improvement	Provides information that is inadequate.	Has an organized plan with many flaws.	Provides inadequate information relevant to the needs of the audience.	Provides some language choices to enhance the topic.
0 Unsatisfactory	Provides no information to explain the topic.	No plan was established.	Does not provide information relevant to the needs of the audience.	Provides no language choices to enhance the topic.